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(54) Title: ENERGY MANAGEMENT SYSTEM AND METHOD (54) Titre: SYSTEME DE GESTION DE L'ENERGIE		
(57) Abstract		
An energy management system (12) and method is provided for energy users with large physical plants (14) which provides these energy users with a comprehensive understanding of the energy consumption of their physical plant (14) and with the ability to manage it in a way that makes sense for their business. The system (12) may include three-dimensional facilities navigation tools, powerful energy consumption analysis processes, TCP/IP communication capabilities and a World Wide Web (WWW)-based interface. The system (12) also includes a real-time data retrieval and dissemination process and system which permits real-time energy data to be communicated within the system (12).		
(57) Abrégé		
L'invention concerne un système (12) de gestion de l'énergie ainsi qu'un procédé correspondant qui permettent aux consommateurs d'énergie qui sont en charge d'importantes installations physiques d'avoir une vue d'ensemble de la consommation de leurs installations (14) et de pouvoir gérer cette consommation de façon économique. Le système (12) peut comprendre des instruments de navigation 3 D, des procédés puissants d'analyse de la consommation d'énergie, des moyens de communication par le biais du protocole TCP/IP et une interface basée sur le Web. Le système (12) comprend également un système et un procédé de récupération et de diffusion des données en temps réel qui permet de communiquer à l'intérieur du système (12) les données relatives à l'énergie en temps réel.		

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(57) Abstract		
<p>An energy management system (12) and method is provided for energy users with large physical plants (14) which provides these energy users with a comprehensive understanding of the energy consumption of their physical plant (14) and with the ability to manage it in a way that makes sense for their business. The system (12) may include three-dimensional facilities navigation tools, powerful energy consumption analysis processes, TCP/IP communication capabilities and a World Wide Web (WWW)-based interface. The system (12) also includes a real-time data retrieval and dissemination process and system which permits real-time energy data to be communicated within the system (12).</p>		

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Description

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ENERGY MANAGEMENT SYSTEM AND METHOD

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Background of the Invention

This invention relates generally to a system and method for managing the use
15 of energy and in particular to a system and method for automatically managing the use
5 of energy for a commercial user.

The problem of energy management and energy cost management has always
20 been an issue for many commercial users who operate large physical plants (i.e.,
facilities and/or factories) because of the large amount of energy which is consumed by
25 the facilities or factories. It is desirable to manage and analyze the energy
10 consumption of the physical plant in order to reduce the total energy costs of the
physical plant. The energy management process may involve many steps such as, for
30 example, purchasing energy from another less expensive source or adjusting the energy
usage of the facility to off-peak times when energy rates are lower. A conventional
35 system for energy management may be a computer system housed in the basement of a
facility or factory, that permits a person to view the energy usage of various equipment
15 within that particular facility and makes changes to the energy usage based on
40 information received at the computer system.

The problem of energy management is especially complex for large entities,
45 such as corporations, universities, municipalities, etc., which may have a physical plant
20 with many different facilities or factories located at various different locations. With a
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conventional energy management approach, each facility owned by the large entity
10 may independently manage its own energy. Thus, for a large entity, there must be a conventional energy management system associated with each facility or factory, which greatly increases the overall cost of conventional energy management. In
15 5 addition, each energy management system may use a slightly different data structure for the data being generated so that these multiple energy management systems cannot be easily integrated into a single energy management system for the entire physical
20 plant.

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In most conventional systems, the task of energy management is separated from
10 the task of facilities management. Thus, each facility generally has both an energy management system and a facilities management system. To reduce the costs of the
30 management of the facility, it is desirable to integrate these two systems into a single system.

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Therefore, it is desirable to provide a single integrated energy and facilities
15 management system which connects a physical plant with multiple, possibly geographically dispersed, facilities or factories together so that the task of energy and
40 facilities management may be accomplished at a single central location. The single control location may be remote from all of the facilities. It is also desirable to provide
45 an energy and facilities management system which provides the user of the system
20 20 with a simulation of the facilities being managed so that the user may view the physical plant without actually being at the site. Thus, it is desirable to provide an
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energy management system and method which provides the above advantages and
10 avoids the problems with the conventional systems, and it is to this end that the present
invention is directed.

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Summary of the Invention

5 In accordance with the invention, an energy and facilities management system
20 is provided for energy users with large physical plants which provides these energy
users with a comprehensive understanding of the energy consumption of their physical
25 plant and with the ability to manage it in a way that makes sense for their business.
The system accomplishes this goal by using, for example, three dimensional facilities
30 navigation tools, powerful energy consumption analysis processes, TCP/IP
35 communication capabilities and a World Wide Web (WWW)-based interface. The
system therefore present large amounts of real-time energy data to users in a clear,
concise and useful format. The system permits the user to alter energy consumption
40 patterns and/or procure power more intelligently in order to save money. To
45 accomplish the real-time movement of the large amounts of energy data, the system
50 may include a robust, scaleable real-time data server component and a scaleable
database which allows for flexibility and ease of integration between products and
modules. The real-time server permits the system to provide a web-based interface
which allows multiple users from a variety of locations to access important energy
55 information at a much lower cost versus existing energy management systems.

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The system, in accordance with the invention, may be divided into one or more
10 sub-systems which manage different portions of the physical plant of the entity. For
example, there may be an energy manager, a facility navigator, a facility manager and
15 an alarm manager in a preferred embodiment of the invention. Each of these sub-
systems performs operations which permit an employee of the entity to control and
20 manage its facilities including its energy consumption. For example, the energy
manager may track and/or analyze energy usage data, the navigator may permit the
25 user to visualize each facility through a simulation, the facility manager may analyze
control problems, and the alarm manager may notify the user of alarms and response to
30 alarms as appropriate. Each of these sub-systems work together to provide an
integrated energy and facility management system.

In accordance with another aspect of the invention, a system and method for
35 moving data between the various sub-systems within the energy management system is
disclosed. The data moving method concatenates data at one or more sources such that
40 the total amount of data being communicated between the sub-systems is reduced.

Thus, in accordance with one aspect of the invention, a system for managing
45 the facilities and the energy consumption of a physical plant is provided in which the
physical plant has one or more facilities and buildings in which each building and
facility has one or more devices which operate and consume energy. To accomplish
50 the management of the physical plant, the system may gather information about the
energy consumption and operation of each device in the physical plant and control the

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facilities, buildings and devices in the physical plant, based on the energy consumption
10 and operating information for each device, by communicating the energy consumption
and operating data in real-time between the devices and the energy and facility
management apparatus. The system may also include a user interface for requesting
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- 5 energy consumption and operation data about one or more devices and for viewing the
energy consumption and operation data about the physical plant. A method for energy
20 and facility management is also provided.

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In accordance with another aspect of the invention, an apparatus for managing

- 10 the facilities and energy consumption of a physical plant including one or more pieces
30 of equipment and one or more facilities is provided in which data is received from each
facility corresponding to building control signals, energy usage signals and weather
data and external data is received corresponding to energy rates and weather forecasts.

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- The apparatus may generate energy management data for the facilities and equipment
15 in the physical plant based on the facility data and the external data. It may also
40 generate a representation of each facility in the physical plant so that a user navigates
through each facility. The apparatus may also generate facility management data to
help a user of the apparatus control the facilities of the physical plant.

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In accordance with another aspect of the invention, a system for

- 20 communicating data in real-time between an energy and facility management system
50 and the devices of a physical plant is provided in which a plurality of devices in the

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physical plant operate and consume energy. The system may include a device interface

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connected to one or more of the devices for gathering energy consumption and

operation data about the one or more devices connected to the device interface and a

server connected to the device interface for storing the energy consumption and

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5 operation data for each device in the physical plant. The system may further include a

plurality of client applications which request to receive energy consumption and

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operation data about one or more devices in the physical plant from the server, and a

concentrator connected to one or more of the client applications. The concentrator may

analyze the requests for data from the client applications, combine requests for energy

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10 consumption and operation data about a particular device into a single combined

request, communicate the single combined request to the server, and route the energy

30 consumption and operating data about the particular device received from the server to

each client application which requests the energy consumption and operation data

about that particular device.

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15 Brief Description of the Drawings

Figure 1 is a diagram illustrating a geographically diverse enterprise having one

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more facilities and an integrated energy and facilities management system;

Figure 2 is a block diagram illustrating an energy and facility management

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system in accordance with the invention;

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Figure 3 is a diagram illustrating the data flow through the energy and facility
10 management system shown in Figure 2;

15 Figure 4 is a diagram illustrating more details of the real-time data topology of
the energy and facility management system of Figure 2;

5 Figure 5 is a flowchart illustrating a method for updating data in real-time in
20 accordance with the invention;

Figure 6 is a flowchart illustrating a method for registering a client and with a
25 concentrator device in accordance with the invention;

Figure 7 is a flowchart illustrating the operation of the client and concentrator
30 device in accordance with the invention; and

Figure 8 is a diagram illustrating the real-time data structures for the server in
35 accordance with the invention.

Detailed Description of a Preferred Embodiment

40 The invention is particularly applicable to an energy and facility management
45 system for an energy user having a widely dispersed enterprise with widely dispersed
energy consuming factories or facilities. The energy and facility management system
may use a public global communications network known as the Internet/Intranet to
communicate data between the elements of the system. It is in this context that the
invention will be described. It will be appreciated, however, that the system and
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method in accordance with the invention has greater utility, such as to other smaller,
10 less complex physical plants and may use a variety of communications systems,
including a private network, to communicate the data.

15 Figure 1 is a block diagram illustrating a physical plant 10 of a large entity
5 which may be controlled and managed by a central energy and facilities management
20 system 12 in accordance with the invention. As shown, the physical plant of the entity
may include one or more facilities 14 (Facility #1, Facility #2, Facility #3 and Facility
#N) each of which consumes power and has facilities management requirements. In
25 this example, these facilities may be located in widely disparate geographic locations,
10 such as Palo Alto, California, Los Angeles, California, New York and Texas. It should
be noted that the invention, however, is not limited to any particular number of
30 facilities or the locations of those facilities since the system may also be used for an
entity with just a few facilities in the same geographic location. As described above, it
is desirable to be able to control and manage the energy consumption and other
35 facilities problems from a single centralized location.

40 To provide a centralized energy and facilities management system, the system
12 may be interconnected to the facilities 14 by any conventional communications
45 systems 16. In a preferred embodiment, the system 12 and the facilities 14 may be
interconnected by the Internet/Intranet. The communications system permit data to be
20 communicated between the facilities 14 and the energy and facilities management
system 12 in real-time. To provide an interface between the energy and facilities
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management system 12 and each facility 14, each facility may include an energy
10 management device (EM) for communicating data between the energy and facilities
management system 12 and the facility 14 as described below in more detail. In
15 particular, the combination of the system 12 and the EM devices permit real-time data
5 to be communicated between the system 12 and the facilities 14. In accordance with
the invention, a user at the energy and facility management system 12 may control and
20 manage each of the facilities without necessarily being on-site at any of the facilities.
The energy and facilities management system 12 may permit, for example, the energy
usage of each facility to be monitored and an alarm sounded if a predetermined
25 condition occurs. Because the energy and facility management system 12 is connected
10 to the facilities 14 by a communications system 16, the energy and facility
management system 12 may be located at any geographic location while providing
30 complete control and management of all of the facilities in the physical plant 10. In
addition to the facilities 14, one or more user terminals 17 may also be connected to the
35 system 12 by the communications system 16, which may preferably be the
Internet/Intranet. These terminals 17 may be located at any location where access to
40 the communications system 16 is available. For example, a manager may access real-
time energy data from a facility in Singapore while in New York. In addition, there
45 may be multiple people at various different locations accessing different or the same
20 energy data at the same time due to the real-time data retrieval and dissemination
system as described below in more detail. Thus, anyone in the entity may access any
50 energy data about the physical plant at any time. The actual data displayed to each

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user may be customized based on the user's needs so that each user may receive
10 different data or the same data presented in a different way. For example, a CFO may
receive a different set of data than an energy manager. Now, the energy and facilities
management system 12 will be described in more detail.

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5 Figure 2 is a block diagram of the energy and facilities management system 12
in accordance with the invention which provides energy and facilities management
20 capabilities for a physical plant. The system may include one or more internal data
sources 22, one or more external data sources 24 and an energy and facility
25 management apparatus 26. The internal data sources 22 may be devices internal to the
facility which generate data about the facility used for energy and/or facility
10 management. For example, the internal data sources may include a building control
management apparatus 26 which provides one or two-way data communications between the existing
30 controls of the facility and the apparatus 26, a meter gateway 30 which provides data to
the apparatus 26 about the energy usage of the facility, and a weather gateway 32
35 which provides various weather data, such as humidity or temperature, to the apparatus
15 26. The external data sources may be data sources which are outside of the particular
facility, but which also provide data which is useful for energy and facility
40 management. For example, the external data sources may include a market energy
rates source 34 which contains data about the energy costs for various energy providers
45 and a weather data source 36 for providing future weather forecasts for each facility.
Using the various data from the internal and external data sources 22, 24, the energy
50 and facility management apparatus 26 may, for example, track energy usage or change

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energy usage patterns based on the forecast weather or based on a less expensive
10 energy provider. The various energy management processes will be described below
in more detail.

15 The apparatus 26 may be a computer system which executes a plurality of

5 different software packages which implement the functions of the system which are
described below. As shown, the apparatus 26 may include an energy manager 40, a
20 facility navigator 42, a facility manager 44 and an alarm manager 46. Thus, the
apparatus may be divided up into four components and a customer may select features
25 from some or all of these components to create a product bundle that most closely fits
their needs. The invention, however, is not limited to an apparatus which includes all
10 of these components and thus the invention may include only one or more of the
components. Each of these components may be implemented as a piece of software
30 being executed by a server computer, for example. Each of these components will now
be described in more detail.

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15 The energy manager 40 gathers energy usage data and permits users of the
system to view and analyze energy usage over any combination of facilities or time
40 periods. The energy manager may permit the user to diagnose energy usage problems
and develop strategies to reduce energy costs by optimizing responses to queries by the
45 user based on the time of day, the current energy rate and environmental conditions.
20 The energy manager may receive data from a variety of sources, such as utility meters
in the facility. The energy manager may perform a variety of functions, such as

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tracking energy usage, analyzing energy usage by analyzing historical energy usage
10 data or analyzing energy load aggregation data, energy rate analyzing, energy usage
forecasting based on various data such as forecast weather conditions, power
procurement analyzing, such as generating a request for purchase (RFP), analyzing the
15 5 energy usage of different sites and comparing the sites to each other and alarm
signaling. In more detail, the usage tracking may include monitoring and generating
20 trends for real-time energy usage of each facility in various energy units, such as
kilowatts (KW), kilowatt hours (KWH), or British thermal units (BTUs). The usage
tracking may also include aggregating energy loads for the various facilities and
25 10 retrieving and comparing historical energy usage with real-time energy usage. The
energy usage analysis may include an energy load shape analysis, a peak energy
demand determination, an identification to determine the largest energy consumers
30 15 and/or the consumers who use the energy during the peak energy usage time, and a
determination of energy load and energy power factors as is well known. The rate
analysis may include determining energy costs based on existing rates on a per meter,
35 20 per building, per site, per cost center or corporate wide basis, an energy load scenario
builder in which different energy rates scenarios may be played out to determine the
best rate for the entity compared to a base scenario, generating energy bills, and
40 viewing real-time and historical energy demand levels on a per meter, per building, per
site, per cost center or corporate wide basis. The usage forecasting may use weather
45 25 data to forecast a future day, week, month or year's energy usage. An alarm signaling
function may generate an alarm signal when certain conditions occur, such as energy
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load peaks, power spikes, surges, sags and deviations from an acceptable signal quality
10 and keep track of the total number of alarms. Now, the facility navigator 42 will be described in more detail.

15 The facility navigator 42 may permit any user of the energy and facility

5 management apparatus 26 who is connected to the apparatus by the communications system 16 (see Figure 1) to view real-time two-dimensional or three-dimensional
20 representations of any facility in the physical plant, to configure a particular site, to analyze and locate energy or facility management problems at a site, or to generate a report. In particular, the facility navigator may permit a user to navigate and analyze
25 problems at multiple sites using advanced 2-D and 3-D visualization tools. In more detail, the two-dimensional navigator may generate graphical representations of the details of the facilities, sites and the like to permit the user to navigate through all of the sites, through a site to a specific building on a site, or through a particular building
30 on a site. The navigator may also generate visual representations of an event, such as
35 an alarm or excessive power usage, so that the user may see these events when they are navigating through the site or building. As an example, the navigator may display a
40 particular building as red indicating that the building is using too much power based on past history and the user of the navigator will see the red building and may investigate
45 the problem. The navigator may also permit the user to look at individual systems in a building, such as HVAC system or equipment components, to analyze a problem. The
50 three-dimensional navigator may perform similar functions as the two-dimensional navigator, but in three-dimensions. The site configuration functions permits the user of

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the apparatus to customize , create or update a particular site to add various
10 information. For example, the site configuration may permit the user to generate a site
map for a newly opened facility which is going to be managed by the apparatus 26.

15 The facility manager 44 may integrate existing building control systems to
permit the user of the apparatus to have access to data from the existing building
control systems as well as newly installed systems so that the apparatus 26 may be
20 easily integrated with existing systems. The facility manager may perform data
monitoring and collection processes which may include monitoring, trending and
25 archiving data (i.e., temperatures, pressures, flows, levels, set points and states) about
10 existing systems, such as HVAC systems, boilers, chillers, cooling towers, generators,
compressors, motors and pumps and lighting. The facility manager may also monitor
30 and trend (i.e., determine a trend and how the particular quantity will act in the future)
environmental conditions, such as lighting, interior and exterior temperatures, relative
35 humidity, solar radiation and the like. The facility manager may also monitor and
15 display peak facility operating periods. The facility manager may also analyze
equipment efficiencies under partial and full load, develop operating efficiency load
40 profiles, track operating hours and benchmark load profiles against capacity ratings.
The facility manager may also optimize the existing systems by, for example,
45 balancing HVAC operating times to meet building use periods and environmental
20 changes, and optimize existing equipment's usage. The facility manager may also
control the existing systems and devices and initiate soft starts, hard starts and stops of
50 the equipment, program control set-points and provide a manual override of the

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systems and equipment.

10 The alarm manager 46 handles any alarms generated at any point in the apparatus 26 or physical plant 10. For example, it may collect alarm information from
15 the energy manager or the facility manager and then prioritize these alarms. The alarm
20 manager may also notify the appropriate people, by various different methods, such as
25 e-mail, fax or pager, who need to respond to a particular alarm. Now, the flow of data
through the energy management system in accordance with the invention will be
described with reference to Figure 3.

25 Figure 3 is a diagram illustrating an example of a physical plant 50 of a
30 10 commercial user which may include one or more buildings 52, 54, 56, 58 and
additional equipment and devices (D) which may be controlled by the energy
35 management system in accordance with the invention. The energy management
system may include one or more computer systems 60, 62, 64 which may be server
computers which interconnect the various buildings and equipment of the physical
40 15 plant for purposes of controlling and managing the buildings and the equipment. In the
example shown, the energy management system may include the central server 60
45 40 which receives data and information from the other servers, the buildings and the
equipment. The invention, however, is not limited to a energy management system
with a central server.

50 20 At each building, a user executing a client application on a personal computer,
55 50 for example, may query one of the servers and receive data about some portions of the

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entity's physical plant. In the example shown in Figure 3, each client application requesting data about the enterprise may be represented by a client object in an object oriented programming language. Therefore, in accordance with the invention, in order to provide information to a particular client application, the client object corresponding

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5 to the client application may be modified and then the client application may read the modified client object. For example, in building 54, a first client application/object 66 and a second client application/object 68 may access information about the physical plant. In the embodiment shown, the client applications may be client software applications being executed on a computer system within the building which access 20 data from the servers. In the preferred embodiment, the client applications/objects may be Internet/Intranet browser software applications which access the servers over the Internet/Intranet to communicate data and commands to the servers. For locations, 25 buildings or sites in which more than one client application is being executed, the energy management system may include a data concentrator (C) which attempts to 30 reduce the data traffic between the client application and the servers by combining 35 requests from the client applications into a single request. For example, if both client applications are requesting the same updated data about a particular piece of equipment, the concentrator may generate a single request for the data and then 40 communicate that updated data to each client application once the updated data is 45 received by the concentrator.

The equipment and devices (D) may be connected to the servers 60 - 64 by a gateway (G) which acts as an interface between the device D and the servers. In

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particular, the gateway may be a software application which interprets the particular
10 device or equipment's signals into standardized data which may then be stored by the servers. Therefore, each gateway G may be somewhat unique since it converts signals from a particular device D into a standard format.

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5 In operation, the devices D may generate data about the operation of the device or its energy usage and pass the data to the gateway which forwards it on to the server
20 which stores the data. When a client application requests data about a device, the request is passed to the concentrator associated with the application which filters out any duplicate requests. Then, when a concentrator requests data about the device, the
25 10 server may communicate the data to the concentrator which passes the data onto the appropriate client application. A similar process may occur to update data about a device. To accomplish the real-time retrieval and dissemination of data, a unique address is assigned to each device and client application in the real-time data retrieval
30 and dissemination system as will now be described.

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15 Figure 4 illustrates more details of a real-time data retrieval and dissemination system 100 in accordance with the invention. In a preferred embodiment, the real-time
40 data retrieval and dissemination system 100 may be implemented as a sophisticated software system containing a plurality of software applications which can perform various energy and facility management tasks. For example, the system 100 may
45 20 remotely interface to various data acquisition and control systems over existing data networks (i.e., an internal computer network or the Internet/Intranet) thereby

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eliminating the need for proprietary, expensive cabling to remotely locate a control
10 system user-interface software application which permits a user to control and manage
the entire physical plant of an organization from one location. In addition, because the
15 system 100 interfaces to and consolidates the data from a variety of different systems

5 having possible different data protocols into a central data server, a user of the system
may utilize a common workstation to access and combine the functionality of different
20 control systems from the same location using the same software. As with the
equipment and physical plant which may be distributed over a large geographic area,
the client software applications, which permit access to the data, may also be located

25 10 anywhere within the span of the data network. This is especially advantageous since
the number and type of client applications requesting for real-time information will
30 grow significantly in the future, as this information becomes integral in optimizing the
asset utilization of the enterprise. This permits the system to be scaleable and
accommodate future expansion of the physical plant. It also permits the person

35 15 controlling the physical plant to access data about the physical plant from any location.

40 | It also permits other people in the organization, such as the chief financial officer, to
access data about the physical plant from his desktop computer which has a browser.

In the example shown, the system 100 may include a central server computer 102, one
45 20 or more client personal computers 104, 106, 108, one or more gateways 110, 112, 114,
116 which connect one or more devices 118, 120, 122, 124, 126 to the server 102.

Each of these will now be described in more detail.

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The data gateways 110, 112, 114, 116 may be stand-alone software application
10 modules that interface with the devices to perform data acquisition and to control the
devices. As shown, multiple control systems or data collection devices of different
15 types may be supported by a single data gateway. The communication medium
5 between the gateway and the data collection device may vary. The data gateways may
also be connected to a second data network to permit the gateway to communicate data
20 with the server 102 to perform various functions, such as exchanging collected data or
forwarding control commands from the energy management system to individual
25 devices for execution. Each gateway may also include a configuration system 127 for
10 configuring the gateway to a particular device. Now, the server 102 will be described
in more detail.

30

The server 102 is the controller for the real-time data retrieval and
dissemination system. The server may be implemented as an individual software
35 process executing on a single computer or as several software processes being executed
15 on a network of multiple computer systems. In either case, the configuration of the
server is transparent to the client software application being executed by the client PCs.
40 The distributed server architecture with multiple servers executing various pieces of
software may be especially well suited for scaling up the energy management system
to handle very large applications of real-time data without affecting any development
45 20 within the client application. In accordance with the invention, the server may execute
software applications which implement the various sub-systems described above with
reference to Figure 2. The server 102 may include a real-time database (Rtdb) 128 and

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a configuration database 129 which communicate with each other. The Rtdb may
10 receive data from the gateways, issue commands to the devices, and disseminate data
to the client PCs 104-108. The configuration database 129 may receive configuration
15 data from a gateway for a particular device and forward updated configuration data to a
device and gateway. More detail about the operation of the server will be described
below.

20

Each client PC 104, 106 or 108 may include one or more client objects 130,
132, 134 which are connected to a concentrator 136. As described above, the client
25 objects, which may be software applications being executed by the client PC, such as a
10 Internet/Intranet browser, may generate requests for data from the server 102 which the
concentrator 136 may combine together if possible. The concentrator 136 thus may act
30 as a data traffic controller to prevent the client objects from overloading the server 102
with duplicate requests. The concentrator, therefore, reduces the data traffic flow
between the server 102 and each PC. The client application may consist of one or
35 15 more stand-alone software application programs or modules that can communicate
independently to the server 102 to receive real-time data updates of data element status
40 changes which are displayed visually for the client in a variety of ways, such as using a
web browser. Thus, data is automatically updated for each client application as will
be described in more detail below. Now, the flow of changed data through the real-
45 20 time retrieval and dissemination system 100 will be described to better understand the
operation of the system.

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When a data change occurs on a device 118 - 126, a data gateway 110 - 116 attached to the device may detect or be signaled of the data change depending on the capabilities of the device. Once the gateway receives the changed data, it may preprocess the data to standardize it for the energy management system and 15 communicate it onto the Rtdb server 102. Upon arrival of the changed data at the Rtdb server , the Rtdb server checks an update list to determine which concentrators 136 are currently registered to receive data updates for this device. The current list of 20 concentrators which receive the updated data for a particular device changes in real-time based on what data each concentrator is currently requesting or what data is being 25 currently displayed by each client PC.

Once the list of registered concentrators is determined, the Rtdb server may 30 send the updated data to each concentrator 136. When a data update is received by a concentrator, the concentrator may in turn check a local list to see which client applications/objects 130- 134 attached to the particular concentrator are registered to 35 15 receive the particular data updates. Next, the client concentrator may send the data update to each individual client application which updates its display based on the 40 updated data. The client concentrator 136 therefore optimizes the efficiency of the data communication network by concentrating identical point data update registrations from multiple client applications/objects into a single request for data from the Rtdb server. 45 20 Therefore, data requests by multiple client applications/objects may be serviced by a single data point update message from the Rtdb server which may be referred to as a 50 point concentration process.

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The point concentration process extends itself beyond the client objects to the
10 Rtdb server 102 so that the server may act as a hub for all points (devices) that it
services from its attached gateways, but in addition act as the hub for points from other
15 Gateways attached to other Rtdb servers. Therefore, any client application/object that
5 needs real-time updated information from any Gateway will receive that data from a
local Rtdb server, who in turn is responsible for obtaining that information from other
20 Rtdb servers, if necessary. To accomplish this, each server 102 may be viewed as just
another concentrator to each "remote" Rtdb server. In other words, for data requested
from another server, each server may concentrate multiple data requests for
25 10 concentrators and client applications attached to it into a few data requests to reduce
data traffic. Thus, the Rtdb server exhibits the same network optimization strategies as
30 the client concentrator objects by concentrating identical point update registrations
from multiple concentrators into a single registration to the remote Rtdb server.

Throughout the system 100, registrations (requests) for real-time point (device)
35 15 updates are initiated by client applications/objects by specifying a unique machine
identifier and a unique point identifier combination for each device/point of interest to
40 its associated concentrator. Thus, each server (machine identification) and
device/point (point identification) has a unique address so that data may be efficiently
45 20 routed through the communications network. For example, a client application
attached to server A may request data from a device B by issuing a command
indicating that A requests data about B so that the command contains the necessary
50 addresses used by the concentrator and other server to route the data about device B to

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the client application attached to server A. The concentrator then registers these
10 points, if not already registered, with a local Rtdb server. Based on the machine
identifier associated with each registered point, the Rtdb server can then pass a
15 registration onto another Rtdb server if necessary, again, only if this point has not
already been registered with that Rtdb server. This system of concentrating and
20 forwarding point registrations lends itself to very simplistic administration because
each Rtdb server requires no advance knowledge of other Rtdb servers anywhere else
in the world as the machine identifier contains all of the information required to locate
a Rtdb server. For example, the machine identifier may be composed of a unique
25 TCP/IP address, a unique Uniform Resource Locator (URL), or a unique Domain
Name Service (DNS) name which permits each Rtdb server to be individually
30 identified. This process also naturally lends itself to scale up to handle very large real-
time data applications.

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In summary, to accomplish the real-time data retrieval and dissemination in
accordance with the invention, each client application/object is given a unique address,
such as that contained in a MachineID variable and each point or device is given a
unique address, such as that contained in a PtID variable. Thus, for any data request or
any update of existing data, there is an associated PtID or MachineID variable which
permits the system to rapidly communicate the data only to the clients which need the
information. Now, the operation of the server during a point data update will be
described.

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Figure 5 is a flowchart illustrating a method 150 for point data updating at the server in accordance with the invention. In step 152, a gateway attached to the device/point with updated data call a Rtdb.UpdatePoint software subroutine which stores values for various variables, such as a machine identification (MachineID), a point identification (PtID), a value of the changed data (Value), a date and time of the data change (DATETIME) and a status of the point/device at the time of the change (status) and passes the values in the variables onto the server. The server, in step 154, then fetches the updated data using the values contained within the subroutine variables from the gateway and stores the values in temporary storage while an authentication process occurs.

In the next series of steps, the server authenticates the data update prior to distributing the data update values to other servers and/or clients. Thus, in step 156, the server determines whether the gateway is marked as running (i.e., whether the server is aware of any problem with the gateway) when the update data subroutine is invoked. If the server detects that the gateway is not running, the data update process ends and no data update is completed. If the gateway is running, then in step 158, the server checks its data records to determine if the point with a data update is actually known to the server since the server maintains a list of the points which are connected to it. If the point is unknown, the method ends and no data update is completed. If the point is known to the server, then the server determines if the updated data from the known point has the proper data type in step 160. If the data type is not correct, the method ends and no data update is completed. Thus, in steps 156 - 160, the server may

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authenticate a point data update prior to distributing the data update in order to reduce
10 incorrect data within the system. Thus, each server attached to each point may act as a filter for updated data from that point.

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Next, in step 162, the server updates various variables in a real-time

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- 5 (Rtdb)database in the server to reflect the updated data values. In particular, the server may update the values of a Rtdb.Value variable containing the new updated value of the point data, a Rtdb.Timestamp variable containing the time and date information about when the data was updated, and a Rtdb.Status variable containing information about the status of the point when the data update occurred. In the next series of steps,
25
10 the server may determine the appropriate one or more other servers or concentrators to which the updated point data may be communicated. This process may be referred to
30 as a Point Hot Link Manager shown diagrammatically as step 164 in the flowchart.

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The Point Hot Link Manager process starts at step 166 in which the server determines, based on a list maintained in the server, which clients may be

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- 15 linked/registered to the particular point which has updated data. If there are no known clients which are registered to receive the updated data, the method ends and the updated data is being retained in the server until a client requests the data. In step 168, the server may determine, from its internal list, whether the particular client is another
45 Rtdb server, a concentrator or something else based on the Machine ID variable. If the client is not another Rtdb server or a concentrator, the method ends. If the client is another server or a concentrator, then in step 170, the server may retrieve a pointer to
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the particular client's interface from an internal file moniker. Next, in step 172, the
10 server may call an Object.UpdatePoint subroutine which updates various variables,
which are described above, in a data structure which is then communicated to the
client. In this example shown, a MachineID variable, a PtID variable, a Rtdb.Value
15 variable, a Rtdb.Timestamp variable and a Rtdb.Status variable are updated to reflect
the change in the point data. The calling of the subroutine thus updates the values for
20 the particular client as identified by the MachineID variable value so that client
automatically receives the updated data anytime an update occurs.

25

Next, in step 174, the server determines if there are any more clients who are
25 registered to receive the updated data. If there are additional clients who are registered
10 to receive the updated data, the method loops back to step 168 and repeats steps 168 -
30 172 to update the data for the next client. Once all of the clients who are registered to
receive data updates for the particular point are accounted for, the method ends. In this
35 manner, for each point data update, the server may perform some authentication of the
15 updated data and then proceed to distribute the updated data only to those clients which
are registered with the server using the unique addresses as described above. In this
40 manner, the method reduces the amount of data traffic over the communications
network. Now, a method by which each client application/object may register itself to
45 receive data updates from a particular point will be described.

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20 Figure 6 is a flowchart illustrating a method 180 by which a particular client
application may become registered to receive data updates from a particular

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point/device. In step 182, the client application may identify the points from which the
10 client application wants to receive data. In particular, the client application may build
an IPointsCollection data structure containing a collection of the IPoIntData objects
that identify the one or more data points about which the client is interested in

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5 receiving data. The data structure may contain a plurality of data structure of the form
"MachineName::point name". For example, the user of client application A may be
20 currently viewing the data regarding device/point B and therefore, the client
application will enter a data structure of the form "A::B" indicating that the particular
client application wants to receive data updates about device B. This data structure
25 may be maintained until the user is no longer viewing the data from device B. Next, in
step 184, the client application may call a subroutine to register the request for the data
from the particular point with the concentrator connected to the client application. In
30 the example shown, the subroutine may be called with the command
Concentrator.RegisterPoints(IPointsDataCollection **pPoints).

35

15 In the next series of steps, the concentrator may register the point data requests
and determine if a request has already been made for the same point data by either the
40 same client application or another client application connected to the same
concentrator. This permits the concentrator to reduce the total data traffic by
concentrating requests for data from a particular point by one or more clients into a
45 20 single data request to the server. The concentrator then distributes the point data to the
appropriate client applications. For each point name in the points collection, the
concentrator may attempt to identify the point in step 186. In step 188, the
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concentrator determines if the point has already been identified (i.e., has the
10 concentrator already previously received data or data requests about the point). If the
point has not been previously identified, then the concentrator may perform a series of
15 steps to request the data for the particular point from an attached server. Thus, in steps

- 5 190, 192 and 194, the concentrator may generate a RtdbRegistrar.GetStaticPointData
command to get any static data about the point, a RtdbRegistrar.GetDynamicPointData
20 command to obtain any dynamic data about the point, and a RtdbRegistrar.Subscribe
command indicating that the concentrator is registered with the server for the particular
point so that the concentrator should automatically receive any updates to the point
25

10 data as described above.

If the point has already been previously identified (i.e., the concentrator already
30 has the data about the point and any updates), then in step 196, the concentrator may
fill in various variables in a data structure with the values for the data for the particular
35 point. In the example shown, the MachineID, PtID, Value, Timestamp,

- 15 ControlCmdTimeout and Status variables may be filled in to provide the data to the
particular client. Next, in step 198, the concentrator determines if there are any other
40 point names to identify and loops back to step 188 if there are additional point names
to identify. If there are no other point names to identify, the method is completed. In
45 summary, this method permits a client application to register its need for data about a
20 particular point and permits the concentrator to avoid unnecessary data traffic by
combining requests about data from the same point by different clients. Now, a

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method by which the concentrator receives updated data from a server in accordance
10 with the invention will be described.

Figure 7 is a flowchart illustrating a method 210 by which a concentrator
15 receives updated data for a point from a server in accordance with the invention. In
5 step 212, the server calls a subroutine to populate a data structure with the updated
data. In the example shown, the subroutine called is "Concentrator.UpdatePoint" and
20 it updates values in a MachineID variable, a PtID variable, a Value variable, a
Timestamp variable and a Status variable. Then, in step 214, for each PointsCollection
containing the correct MachineID value and PtID value, the server may update the
25 values of the point data by updating (step 216), for example, a PointData.Value, a
PointData.Timestamp and a PointData.Status variable. Next, to provide the update to
30 the various clients registered to receive it, the server may call a subroutine, such as
PointsDataCollection.OnUpdatePoint, in step 218, to update the MachineID, PtID,
35 Value, Timestamp and Status values in the appropriate variables. Next, in step 220,
15 the concentrator determines if there are any other PointsCollections which contain the
same MachineID and PtID values as the current updated data. If there are no other
40 PointsCollections with the same MachineID and PtID values, the method is completed.
If there are additional PointsCollections data structure containing the same MachineID
45 and PtID values, the method loops back to step 216 to handle the other
20 PointsCollections. In this manner, when new updated data for a particular point is
received by the concentrator, the concentrator then goes through a process to identify
50 clients attached to it which have registered to receive the updated data and passes the

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updated data onto only the clients which are registered to receive the updated data.

10 Now, an example of the data structures which are utilized by the server in accordance
with the invention will be described.

15 Figure 8 is a diagram illustrating examples of the various data structures

5 utilized by the server in accordance with the invention. It should be noted that this is
only an example of the data structures and the invention is not limited to any particular
20 data structure. As shown, each site of a physical plant may have a site data structure
230 associated with it which may contain a description variable containing a
description of the particular site and a SiteID variable containing a unique address for
25 the site. Each location (i.e., building or other location) within a site may have a
location data structure 232 which may include a Tag variable containing a unique short
30 name for the location, a LocationID variable containing a unique address for each
location, the SiteID variable as described above identifying the site on which the
location exists, a description variable containing a description of the locations, such as
35 building 42, a NumFloors variable indicating the number of floors in the building, a
SqFeet variable indicating the square footage of the location, a TextureType variable
40 indicating the texture that may be used to render the building during the facility
navigation, a DemandThreshold variable indicating when an alarm is generated for a
particular reading, and a Group variable indicating a group to which the location
45 belongs. Each data acquisition may have a system data structure 234 associated with it
which contains a Description variable containing a description of the particular data

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acquisition, a SystemID variable containing a unique address for each system, and a
10 LocationID variable, as described above identifying the location of the system.

For each point/device, there may be a StaticPointData data structure 236, a
15 DynamicPointData data structure 238, an Accumulator data structure 240 and a
5 ControlPointData data structure 242. The StaticPointData data structure 236 may
20 contain static data for a particular device/point and may contain a Name variable which
stores the name of the Point, a PtID variable containing a unique identification for the
point, a SystemID variable as described above indicating the system to which the point
is associated, a Group variable indicating a group to which the point is associated, a
25
10 Priority variable indicating a weighting value for the point, a SortCode variable and a
EU variable containing a text string which identifies the engineering unit associated
30 with the particular point. For each point/device, there may also be the
DynamicPointData data structure 238 containing dynamic data for a particular
35 device/point. The DynamicPointData data structure may contain a PtID variable as
15 described above, a Value variable indicating a value of the point, a MinValue variable
indicating the lowest value for the point over a time interval, a MaxValue variable
40 indicating the highest value for the point over the time interval, an AvgValue variable
indicating the average value for the point over the time interval, a Timestamp variable
indicating the time and date when the data was entered into the system, a Status
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20 variable indicating the status of the point, a PtType variable indicating a type of the
point, and an Archive variable indicating if the current data is archived data. Each
50 point may also have the AccumulatorData data structure 240 containing data about an

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10 accumulator point in the device. The Accumulator Data may contain the PtID variable, a Delta PtID variable containing a delta value identification for a point, ROCPtID
15 variable containing an identification for the rate of change of the point, and a Delta Multiplier variable containing a multiplier for calculating delta pseudo-points. Each
5 point also has the ControlPointData structure 242 associated with it which contains information about the control of the point including the PtID variable, a CmdTimeout
20 variable indicating an amount of time before a control command is timed out, a CmdInProgress variable indicating if a command is currently in progress, the TimeStamp variable, a two control parameters (Param1 And Param2).

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10 The server may also have an ObjectRegistry data structure 244 to register requests for data. It may include a MonikerName variable containing a file name for
30 each registered client, a MachineName variable indicating the machine that the object is associated with, a hEnsRtdb variable counting a Rtdb handle for each object, an
35 ObjectType variable to indicate the type of the object, and a RunningState variable
15 indicating the current state of the object. The server may also have a RtdbServerRegistry data Structure 246 containing data about the machine hosting the
40 Rtdb server including the MachineName variable indicating the name of the machine hosting the Rtdb server, the MachineID variable indicating the logical address, such as
45 TCP/IP, of the machine, and the hEnsRtdb variable indicating the Rtdb handle for the
20 machine. Thus, using this data structure, the real-time retrieval and dissemination system may uniquely identify and address each server and points.

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While the foregoing has been with reference to a particular embodiment of the
10 invention, it will be appreciated by those skilled in the art that changes in this
embodiment may be made without departing from the principles and spirit of the
invention, the scope of which is defined by the appended claims.

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Claims

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Claims:

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1 1. A system for managing the facilities and the energy consumption of an
2 enterprise of an entity, the enterprise comprising one or more geographically dispersed
3 facilities and buildings, each building and facility having one or more devices which
4 operate and consume energy, the system comprising:

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5 means for gathering information about the energy consumption and the
6 operation of each device;

25

7 an energy and facility management apparatus for controlling the facilities,
8 buildings and devices in the geographically dispersed enterprise based on the energy
9 consumption and operating information for each device, the energy management
30 apparatus comprising means for communicating the energy consumption and operating
10 data in real-time between the devices, the facilities and buildings and the energy and
11 facility management apparatus; and
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13 a user interface for requesting energy consumption and operation data about
14 one or more devices, facilities or buildings and for viewing the energy consumption
15 and operation data about a predetermined portion of the enterprise.

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1 2. The system of Claim 1, wherein the gathering means further comprises
2 a gateway device connected to one or more of the devices for gathering energy
50 3 consumption and operation data about the device and for converting the energy

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4 consumption and operation data from a device format to a standard format and wherein
10 5 the energy and facility management apparatus further comprises a server for processing
6 the standardized energy consumption and operation data about the devices from the
15 7 gateway to generate energy consumption management and facility management data, a
8 plurality of user interfaces connected to the server, each user interface requesting data
9 about one or more devices in the physical plant, and a concentrator connected to one or
20 10 more of the user interfaces for interfacing between the user interfaces and the server,
11 the concentrator comprising means for registering requests for data from a particular
12 device by a particular client application, means for combining requests for data from
25 13 the same device into a single data request from the server in order to reduce the amount
14 of data requests to the server.

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1 3. The system of Claim 1 further comprising means for generating a
2 representation of a particular selected facility in the enterprise based on the real-time
35 3 energy consumption and operation data so that a user visually navigates through each
4 facility.

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1 4. The system of Claim 3, wherein the generating means comprises a two-
45 2 dimensional navigator.

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10 5. The system of Claim 3, wherein the generating means comprises a
2 three-dimensional navigator.

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1 6. The system of Claim 1 further comprising means for generating facility
2 management data based on the energy consumption and operation data.

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1 7. The system of Claim 6 further comprising means for managing alarm
2 signals generated by the facility manager and the energy manager in order to alert the
25 3 user of the apparatus to alarm conditions in the geographically dispersed enterprise.

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1 8. A method for managing the facilities and the energy consumption of an
2 enterprise of an entity, the enterprise comprising one or more geographically dispersed
3 facilities and buildings, each building and facility having one or more devices which
35 4 operate and consume energy, the method comprising:

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5 gathering information about the energy consumption and the operation of each
6 device;

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7 controlling the facilities, buildings and devices in the geographically dispersed
8 enterprise based on the energy consumption and operating information for each device
9 using an energy and facility management apparatus comprising communicating the

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10 energy consumption and operating data in real-time between the devices, the facilities
10 and buildings and the energy and facility management apparatus;
12 requesting energy consumption and operation data about one or more devices,
15 facilities or buildings using a user interface; and
14 viewing the energy consumption and operation data about a predetermined
20 portion of the enterprise.

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1 9. The method of Claim 8, wherein the gathering further comprises
2 gathering energy consumption and operation data about the device using a gateway
3 device connected to one or more of the devices and converting the energy consumption
30 and operation data from a device format to a standard format, and wherein the
5 controlling further comprises processing the standardized energy consumption and
6 operation data about the devices from the gateway using a server to generate energy
35 consumption management and facility management data, requesting data about one or
7 more devices in the physical plant by a user interface, and interfacing between the user
8 more devices and the server using a concentrator connected to one or more of the user
40 interfaces and the server using a concentrator connected to one or more of the user
9 interfaces comprising registering requests for data from a particular device by a
10 particular client application and combining requests for data from the same device into
45 11 a single data request from the server in order to reduce the amount of data requests to
12 the server.
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10 10. The method of Claim 8 further comprising generating a representation
2 of a particular selected facility in the enterprise based on the real-time energy
3 consumption and operation data so that a user visually navigates through each facility.

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20 11. The method of Claim 10, wherein the generating comprises using a two-
2 dimensional navigator.

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1 12. The method of Claim 10, wherein the generating comprises using a
2 three-dimensional navigator.

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1 13. The method of Claim 8 further comprising generating facility
2 management data based on the energy consumption and operation data.

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40 14. The method of Claim 13 further comprising managing alarm signals
2 generated by the facility manager and the energy manager in order to alert the user of
3 the apparatus to alarm conditions in the geographically dispersed enterprise.

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50 15. A system for communicating data in real-time between an energy and
2 facility management system and one or more devices of an enterprise which consume
3 energy, the system comprising:

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4 a device interface connected to the one or more of the devices for gathering
10 5 real-time energy consumption data and operational data about the one or more devices
15 6 connected to the device interface;

15 7 a server connected to the device interface for storing the energy consumption
16 8 and operation data for each device in the enterprise into a database, the energy
17 9 consumption and operation data for each device being identified by a unique device
20 10 address;

25 11 a plurality of client applications, each client application requesting to receive
26 12 energy consumption and operational data about one or more devices in the enterprise
27 13 from the server; and

30 14 a concentrator connected between the server and the one or more client
31 15 applications, the concentrator comprising means for analyzing the requests for data
32 16 from the client applications, means for combining requests for energy consumption and
33 17 operation data about a particular device into a single combined request, means for
34 18 communicating the single combined request to the server, and means for routing the
35 19 energy consumption and operating data about the particular device received from the
36 20 server to each client application which requests the energy consumption and operation
37 21 data about that particular device.

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10 16. The system of Claim 15 further comprising means for generating a
2 representation of a particular selected facility in the enterprise based on the real-time
3 energy consumption and operation data so that a user visually navigates through each
15 facility.

20 17. The system of Claim 16, wherein the generating means comprises a
2 two-dimensional navigator.

25 18. The system of Claim 16, wherein the generating means comprises a
2 three-dimensional navigator.

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35 19. The system of Claim 15 further comprising means for generating
2 facility management data based on the energy consumption and operation data.

40 1 20. The system of Claim 19 further comprising means for managing alarm
2 signals generated by the facility manager and the energy manager in order to alert the
3 user of the apparatus to alarm conditions in the geographically dispersed enterprise.

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10 21. A system for communicating data in real-time between an energy and
1 facility management system and one or more devices of an enterprise which consume
2 energy, the system comprising:

15 4 a device interface connected to the one or more of the devices comprising
5 means for gathering real-time energy consumption data and operational data about the
20 6 one or more devices connected to the device interface and means for storing the real-
7 time energy consumption data and operational data into a database object;

25 8 a server connected to the device interface for storing the energy consumption
9 and operation data object for each device in the enterprise into a database, the energy
10 consumption and operation data for each device being identified by a unique device
30 11 object address;

35 12 a plurality of client applications, each client application requesting to receive
13 energy consumption and operational data about one or more devices in the enterprise
14 from the server, each client application having a unique client address; and

40 15 a concentrator connected between the server and the one or more client
16 applications, the concentrator comprising means for analyzing the requests for data
17 from the client applications, means for combining requests for energy consumption and
45 18 operation data about a particular device into a single combined request, means for
19 communicating the single combined request to the server, and means for routing the
50 20 energy consumption and operating data about the particular device received from the

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- 21 server based on the unique client addresses to each client application which requests
10 22 the energy consumption and operation data about that particular device.

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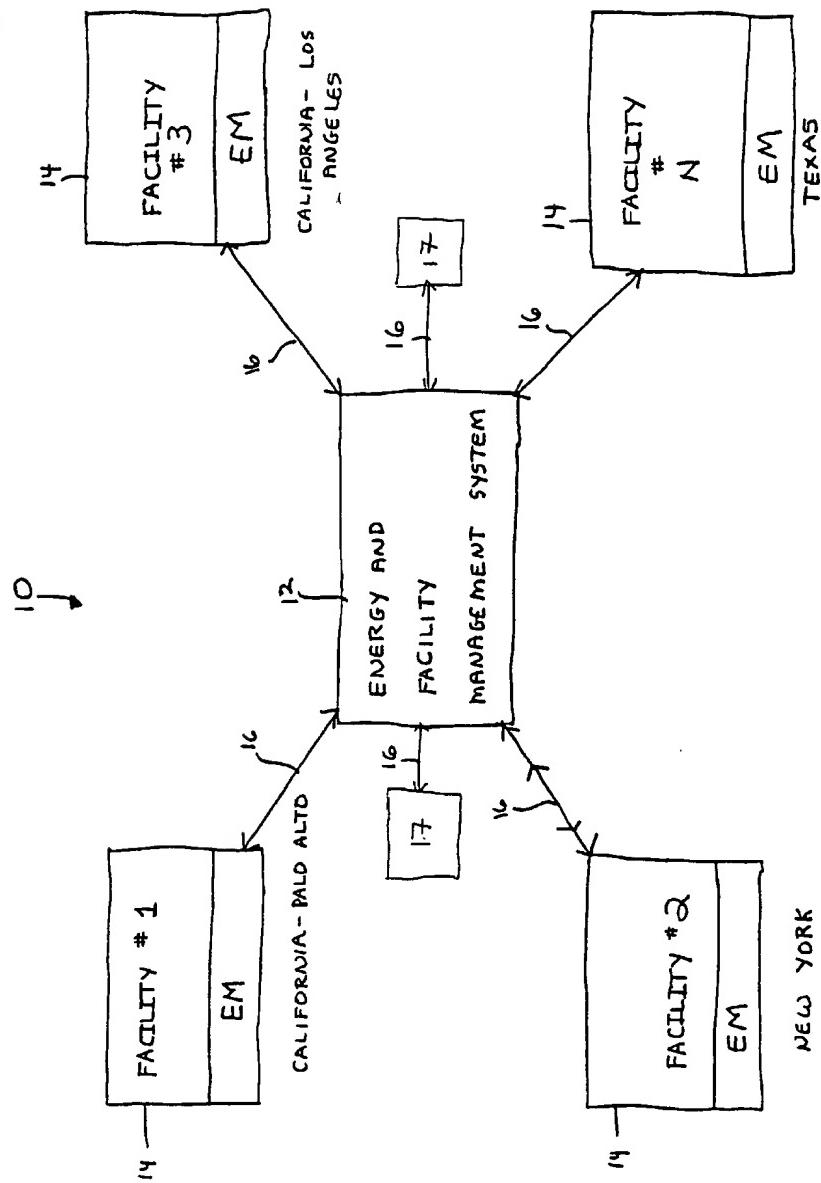


FIGURE 1

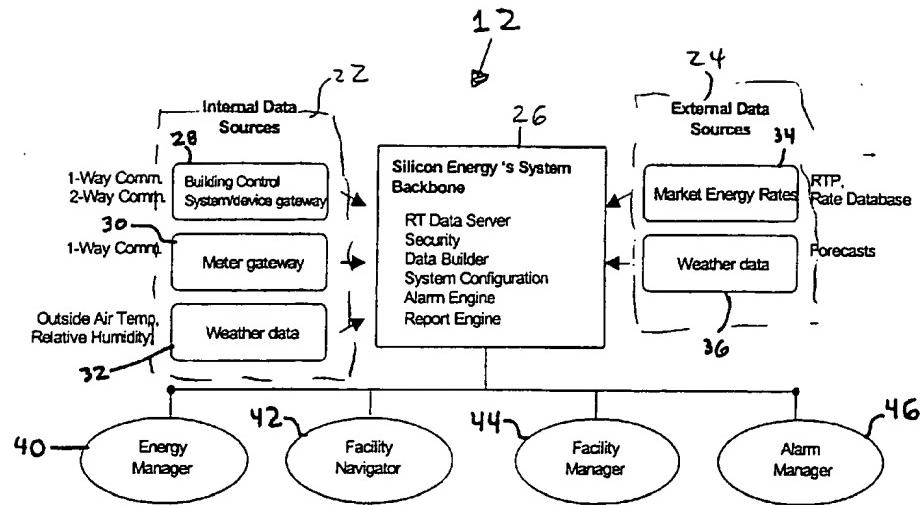


FIGURE 2

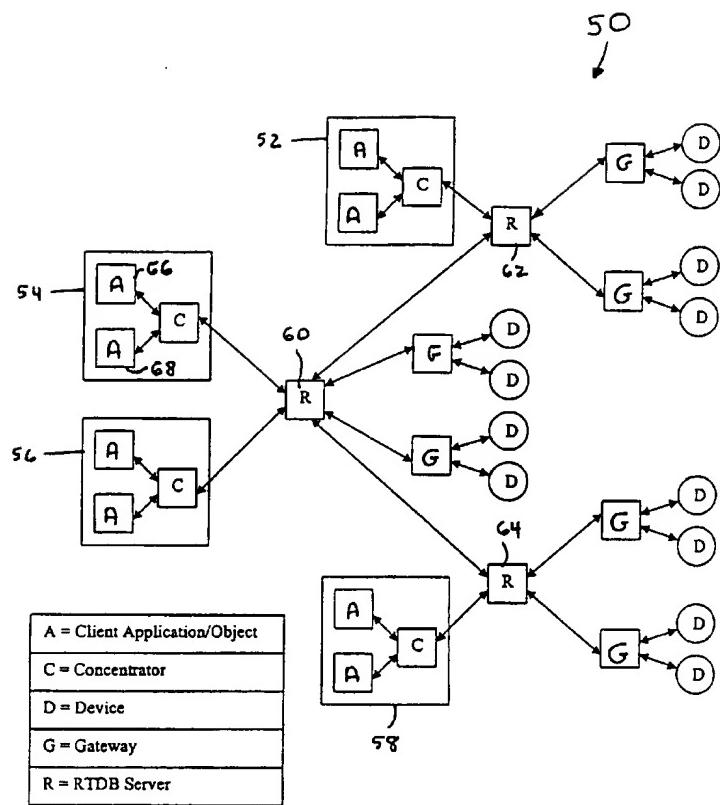


FIGURE 3

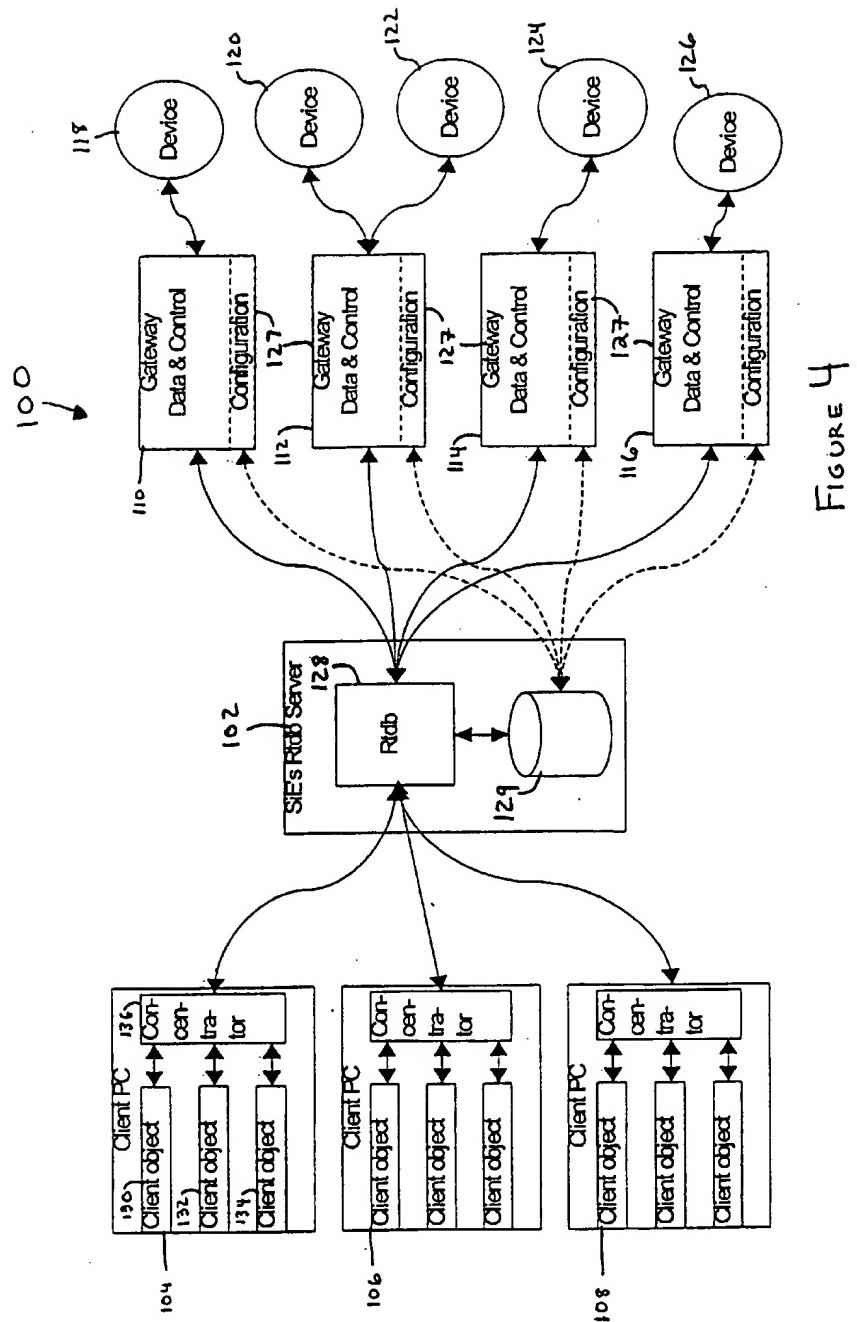


FIGURE 4

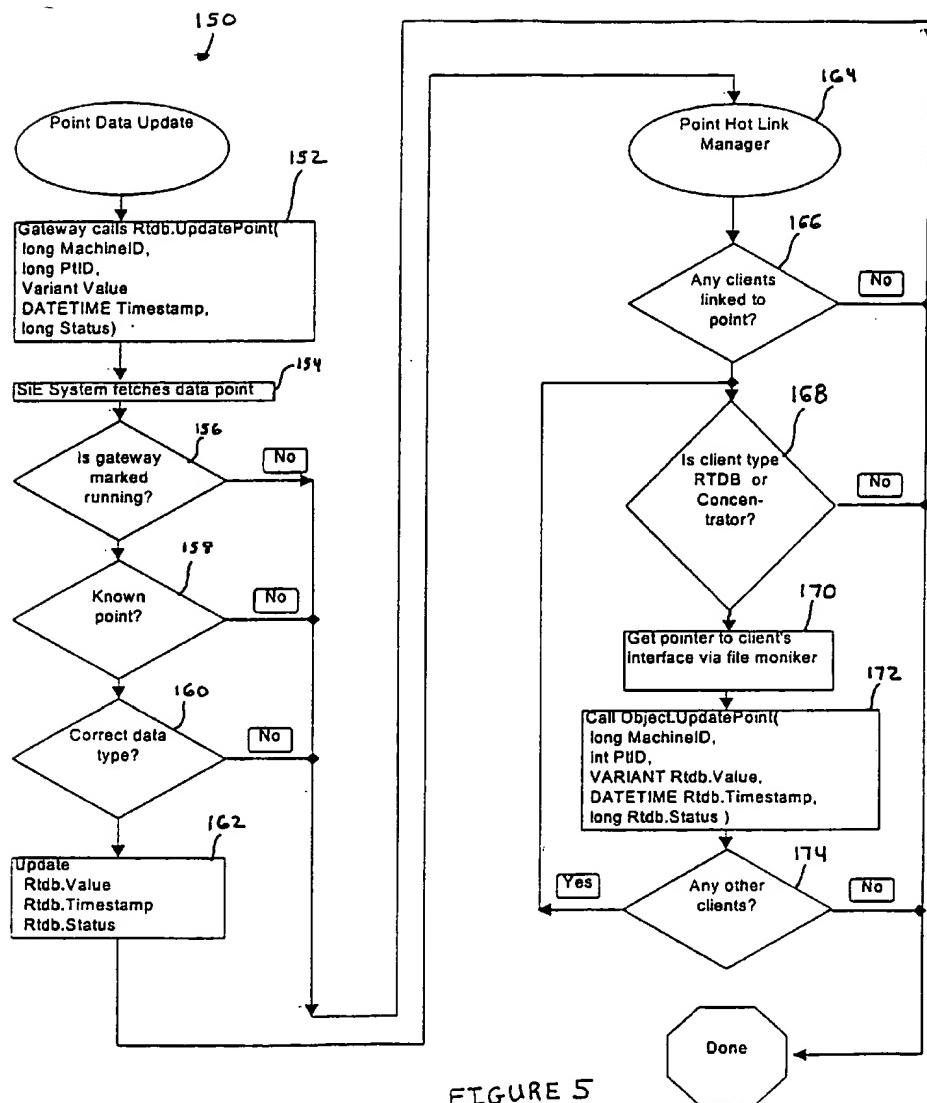


FIGURE 5

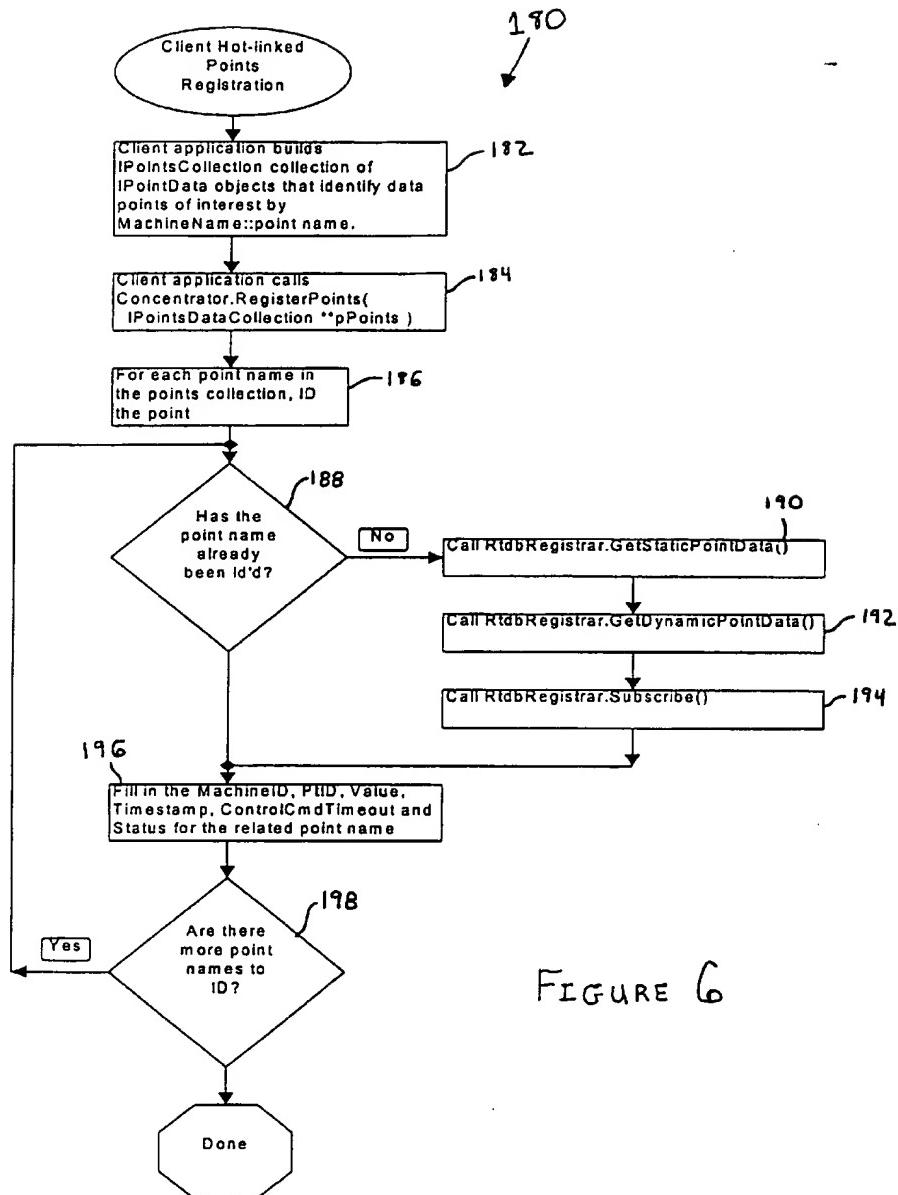


FIGURE 6

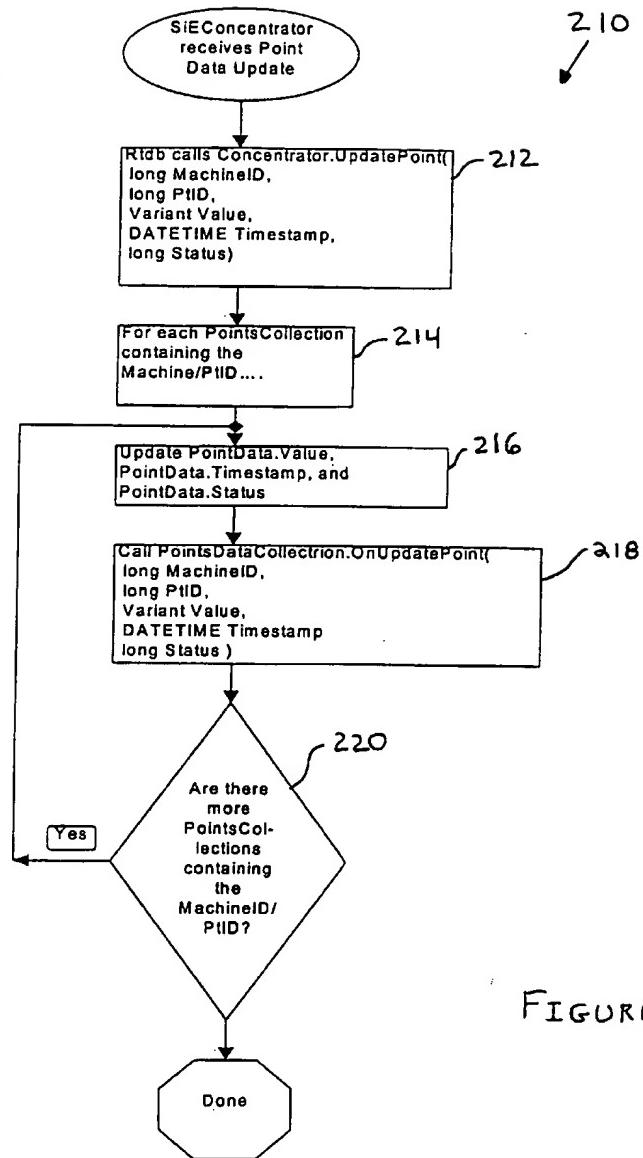


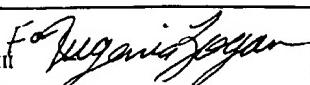
FIGURE 7

Table	Field	Field Type	Identity Column	PK	FK	Notes
Sites	Description	varchar(50)		TRUE		Unique description of site
	SiteID	long		TRUE		Numeric handle for site
Location	Tag	varchar(50)		TRUE		Unique short name for location
	LocationID	long		TRUE		Handle to location
	SiteID	long			Site.SiteID	Numeric handle for site
	Description	varchar(50)				Description of location
	NumFloors	long				Number of floors in building
	SqFeet	long				Square feet in building
	TextureType	varchar(50)				Texture to use for rendering building
	DemandThreshold	double				Warning limit on reading
	Group	long				Group that the location is a member of
System	Description	varchar(50)		TRUE		Unique description of this system
	SystemID	long		TRUE		Handle to this system
	LocationID	long			Location.LocationID	Handle to location
StaticPointData	Name	varchar(64)		TRUE		Unique character string name
	PtID	long		TRUE		Identification for the point
	SystemID	long			System.SystemID	Handle to the owning system
	Group	long				Logical group for point
	Priority	long				Weighting value for point
	SortCode	long				Whatever...
	EU	varchar(15)				Text representation of engineering unit
DynamicPointData	PtID	long		TRUE	StaticPoint.PtID	Identification for the point
	Value	double				Floating point value of the point
	MinValue	double				Highest value of the point for the interval
	MaxValue	double				Lowest value of the point for the interval
	AvgValue	double				Average value of the point for the interval
	Timestamp	DATE				Time set by data source
	Status	long				Status of the point
	PtType	long				Type of point this entry represents
	Archive	boolean				Flag to include in historical archiving process
AccumulatorData	PtID	long		TRUE	StaticPoint.PtID	Identification for the point
	DeltaPtID	long				ID for the delta value of the accumulator point
	ROCPtID	long				ID for the rate of change value of the accumulator
	DeltaMultiplier	double				Multiplier for calculating delta pseudo-point
ControlPointData	PtID	long		TRUE	StaticPoint.PtID	Identification for the point
	CmdTimeout	long				Number of milliseconds to allow before declaring the control command as timed out
		long				Command currently in progress?
	CmdInProgress	boolean				Time set by data source
	Timestamp	DATE				Control parameter 1
	Param1	long				Control parameter 2
	Param2	long				
ObjectRegistry	MarkerName	varchar(128)		TRUE		Marker for registered object
	MachineName	varchar(32)		TRUE		Machine where object is located
	hEnsRtdb	long		TRUE		Real Time Database handle for this object
	ObjectType	long				Enumeration to indicate what type of object is represented by this entry
	RunningState	long				Status of object: Stopped, Running, Paused
RtdbServerRegistry	MachineName	varchar(50)		TRUE		Unique name of the machine that hosts an RTDB server
	MachineID	long				TCP/IP Addr of host machine represented as long word
	hEnsRtdb	long				Real Time Database handle for local RTDB from MachineName RTDB

FIGURE 8

INTERNATIONAL SEARCH REPORT

International application No. PCT/US99/21787

A. CLASSIFICATION OF SUBJECT MATTER														
IPC(6) :H02J 3/12 US CL : 700/295 According to International Patent Classification (IPC) or to both national classification and IPC														
B. FIELDS SEARCHED														
Minimum documentation searched (classification system followed by classification symbols) U.S. : 700/295, 9, 22, 28, 29, 30, 31, 83, 291, 296, 297, 298														
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched														
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) West, BRS Plus														
C. DOCUMENTS CONSIDERED TO BE RELEVANT														
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.												
X	US 5,572,438 A (EHLERS, et al.) 05 November 1996, Abstract, Col. 3, lines 57-61, Col. 4, lines 11 - 23, Col. 15, lines 5 - 11, Col. 9, lines 60 - 62, FIG. 11 - FIG. 15, FIG. 29 - FIG. 37, Col. 5, lines 44 - 48, Col. 3, lines 57 - 65.	1, 3, 6-8, 10, 13 and 14												
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Y		4, 5, 11, 12												
Y,E	US 5,958,012 A (BATTAT, et al) 28 September 1999, FIG. 10F, FIG. 10G, FIG. 10A - FIG. 19, Col. 6, lines 31 - 39.	4, 5, 11 and 12												
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.														
<table> <tr> <td>* Special categories of cited documents:</td> <td>** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>*A* document defining the general state of the art which is not considered to be of particular relevance</td> <td></td> </tr> <tr> <td>*B* earlier document published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>*L* document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>*O* document referring to an oral disclosure, u.e., exhibition or other means</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>*P* document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			* Special categories of cited documents:	** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	*A* document defining the general state of the art which is not considered to be of particular relevance		*B* earlier document published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	*L* document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	*O* document referring to an oral disclosure, u.e., exhibition or other means	"&" document member of the same patent family	*P* document published prior to the international filing date but later than the priority date claimed	
* Special categories of cited documents:	** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention													
A document defining the general state of the art which is not considered to be of particular relevance														
B earlier document published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone													
L document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art													
O document referring to an oral disclosure, u.e., exhibition or other means	"&" document member of the same patent family													
P document published prior to the international filing date but later than the priority date claimed														
Date of the actual completion of the international search 20 DECEMBER 1999	Date of mailing of the international search report 09 FEB 2000													
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